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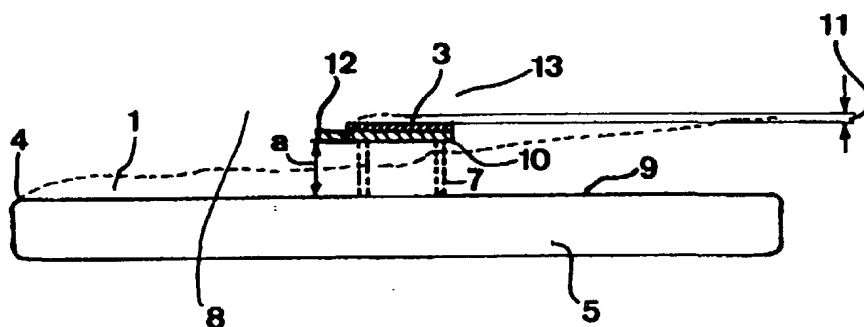


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(54) Title: A METHOD AND A DEVICE FOR EPITAXIAL GROWTH OF OBJECTS BY CHEMICAL VAPOUR DEPOSITION



(57) Abstract

A device for epitaxial growth of objects by Chemical Vapour Deposition on a substrate (3) comprises a susceptor (5) adapted to receive said substrate and means for heating walls of the susceptor surrounding the substrate and by that the substrate and a gas mixture fed to the substrate for the growth. The device comprises also means (7, 10) for holding the substrate in the path (8) of said gas mixture through the susceptor at a distance (a) from internal walls thereof.

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**A METHOD AND A DEVICE FOR EPITAXIAL GROWTH OF OBJECTS  
BY CHEMICAL VAPOUR DEPOSITION**

**10 TECHNICAL FIELD OF THE INVENTION AND PRIOR ART**

The present invention relates to a device for epitaxial growth of objects by Chemical Vapour Deposition on a substrate comprising a susceptor adapted to receive said substrate and means for  
15 heating walls of the susceptor surrounding the substrate and by that the substrate and a gas mixture fed to the substrate for the growth, as well as a method according to the preamble of the appended independent method claim.

20 The objects may be of any material, but the invention is primarily, but not exclusively, directed to the growth of crystals of semiconductor materials, such as in particular SiC and group III-nitrides or alloys thereof, since one of the main problems in such devices for Chemical Vapour Deposition (CVD) is to obtain  
25 such a high growth rate that the objects grown are interesting from the commercial point of view, and this problem is especially accentuated for the materials mentioned, which requires a very high temperature for being grown, and it has been necessary to raise the temperature even more to obtain higher growth rates.

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As a consequence of this, and because SiC is a very interesting material for use in semiconductor devices, the growth of crystals of SiC will hereinafter primarily be discussed for illuminating, but not in any way restricting the invention. It is of course also of  
35 crucial importance that the objects grown has a high crystalline quality, but this invention is primarily directed to obtaining rea-

sonable growth rates from the commercial point of view, but of course without compromising with the crystalline quality.

5 SiC single crystals are in particular grown for being used in different types of semiconductor devices, such as for example different types of diodes, transistors and thyristors, which are intended for applications in which it is possible to benefit from the superior properties of SiC in comparison with especially Si, namely the capability of SiC to work well under extreme conditions. For instance, the large band gap between the valence band and the conduction band of SiC makes devices fabricated from said material able to operate at high temperatures, namely up to 1 000 K.

15 As indicated above, it has been tried to raise the temperatures to which said susceptor and by that the gas mixture fed to the substrate and the substrate are heated above 2 000°C for obtaining reasonably high growth rates. This has also partially been successful, but those very high temperatures are of course associated with several problems, of which the temperature resistance of the material of different parts of the device and introduction of impurities are some.

25 Other ways to increase the growth rate without any reduction in quality are therefore very interesting, especially if they could be combined with other measures increasing the growth rate, such as the use of high temperatures for obtaining a still higher growth rate. Accordingly, a device and a method enabling this would have a large business impact.

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## SUMMARY OF THE INVENTION

35 The object of the present invention is to provide a method and a device according to the introduction, which makes it possible to

increase the growth rate when growing objects by CVD without a reduction in quality.

5 This object is obtained by providing such a device which comprises means for holding the substrate in the path of said gas mixture through the susceptor at a distance from internal walls thereof and a method in which the substrate is held in the path of said gas mixture through the susceptor at a distance from internal walls thereof.

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Accordingly, the inventors have realised that one important parameter upon which the growth rate is dependent is the thickness of a boundary layer at the substrate, and this boundary layer is a layer of the flow of said gas mixture in which the velocity thereof is lower than in the central part of the susceptor. The leading edge of the susceptor at the upstream end thereof creates such a boundary layer, and it is shown for a prior art device in fig. 1 how this boundary layer 1 looks like. The diffusion of species from the free stream above the boundary layer is important for the growth. This diffusion generally depends on the squared diffusive length 2. On the other, it is not possible to arrange the substrate 3 directly at the leading edge 4 of the susceptor 5, since the gas mixture has to be heated to a desired temperature before reaching the substrate, and this gas mixture is heated by radiative heating from the susceptor walls being heated by a heating means 6 surrounding the susceptor, here an Rf-field generating coil. Accordingly, the substrate has to be placed at a substantially distance downstream said leading edge 4, which in the prior art devices results in a considerable diffusive length 2.

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Accordingly, the invention is based on moving the substrate away from the internal walls of the susceptor, through which the influence of the boundary layer 1 created by the leading edge 4 of the susceptor may be reduced or totally eliminated if said distance is large enough. This means that the diffusive length of

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species from said free stream of the gas mixture to the surface of the substrate is substantially reduced and by that a large increase in the growth rate is obtained.

5 According to a preferred embodiment of the invention said means is arranged to hold the substrate separated from said internal walls of the susceptor by at least a distance corresponding to the thickness of a boundary layer with a lower velocity of the gas mixture and created by a leading edge of the  
10 susceptor at the upstream end thereof with respect to the flow of the gas mixture through the susceptor. It is preferred to hold the substrate that much separated from the internal walls of the susceptor, since the boundary layer created by said leading edge of the susceptor will then not at all produce any diffusive  
15 length from said free stream of the gas mixture to the substrate, but any boundary layer next to the substrate will then only depend on the distance between the leading edge of said holding means and the substrate, and this distance can be made as short as wanted.

20 According to another preferred embodiment of the invention said means extends from a rear part of the susceptor with respect to the flow direction of said gas mixture through the susceptor in the direction opposite to said flow while being separated from  
25 and without contact with said internal walls of the susceptor along the extension thereof from said rear part. This means that there will not be any problem of any transport of material from surfaces of the internal walls of the susceptor as a consequence of a temperature gradient between the susceptor walls and a  
30 holding means in contact therewith. In the case that the internal walls of the susceptor are coated by a protective material, such as SiC, this would otherwise be transported to the holding means, so that the susceptor material thereunder, normally graphite, will be bared and in that case increase the total pressure of hydrocarbons in the susceptor. Accordingly, the sus-  
35 ceptor lifetime would be reduced and impurities coming from the

susceptor will be an additional uncontrolled growth parameter. However, these problems are solved by this preferred embodiment of the invention.

- 5 According to another preferred embodiment of the invention said holding means is secured outside a room of the susceptor defined by said internal walls and in which said growth is intended to take place and extends into said room without any contact to said walls therein, said holding means comprises a member secured to the susceptor outside said room and this member has a fork like design with two forks secured to opposite walls of the susceptor while being separated by them from said room. This constitutes a preferred way to realise an embodiment solving the problems of material transport from the internal walls just described.
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- According to another preferred embodiment of the invention said holding means comprises a plate, on which at least two substrates are arranged in series along said gas mixture flow path at said distance to internal walls of the susceptor. Such an arrangement in series in the direction of the gas mixture flow will of course also increase the growth rate in the sense that more objects may be grown at the same time, and this is made possible thanks to the fact that said plate is held at a distance from the internal walls of the susceptor, so that the plate and by that the substrate is not in contact with the walls any longer and will only be heated therethrough by radiative heating and the temperature gradient in the flow direction inside the susceptor will by that be remarkably decreased. This means that a substantially uniform temperature will be obtained over a considerable distance in said flow direction in the susceptor, so that two objects grown in this way in series will have substantially the same growth conditions and by that substantially the same quality.
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- 35 According to another preferred embodiment of the invention the susceptor is adapted to be arranged with said path extending

substantially horizontally therethrough, and the device comprises two holding means, one connected to a ceiling of the susceptor for holding a substrate at said distance therefrom and another connected to the bottom of the susceptor for holding  
5 another substrate at said distance therefrom. This means that the production capacity of the device will be doubled with respect to only arranging one substrate at the bottom of the susceptor as in devices previously known, so that it may be said that the growth rate is increased.

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According to another preferred embodiment of the invention said means is arranged to hold the substrate inclined with respect to the path of the flow of said gas mixture through the susceptor, so that a perpendicular to the surface of the substrate has a  
15 component in the direction opposite to the direction of said flow. It has turned out that such an inclination of the substrate results in optimal growth conditions and also increases the growth rate.

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According to another preferred embodiment of the invention the susceptor is at a downstream end thereof prolonged by an outlet substantially beyond the end of the heating means. This means that the temperature gradient in the flowing direction in the susceptor will be decreased, so that several substrates may be arranged in series in that direction while still obtaining a uniform  
25 growth. This also, in the case of inductive heating, results in a displacement of the end effect and its eddy current flow to the rear part of the outlet instead of the rear part of the susceptor, which is favourable for the temperature distribution inside the susceptor.

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According to another preferred embodiment of the invention at least one heat shield is arranged downstream of an outlet of the susceptor for said flow of gases for reflecting thermal energy back towards the susceptor. Also this inventional feature reduces the temperature gradient inside the susceptor, and more  
35 exactly the temperature is nearly not falling at all from the mid

region of the susceptor to said outlet, so that it will be possible to arrange a number of substrates in series inside the susceptor and grow objects thereon under substantially the same conditions.

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According to another preferred embodiment of the invention the device has an inlet connected to the upstream end of the susceptor and formed by converging walls guiding said gas mixture into the susceptor, which will improve the flow pattern of the gas mixture in the susceptor.

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The advantages of the different embodiments of the method according to the invention appear from the discussion above of the different embodiments of the device according to the invention.

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Further advantages as well as advantageous characteristics of the invention appear from the following description and the other dependent claims.

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## BRIEF DESCRIPTION OF THE DRAWINGS

With reference to the appended drawings, below follows a specific description of preferred embodiments of the invention cited as examples.

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In the drawings:

Fig. 1 is a longitudinal cross-section view of a device according to the prior art,

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Fig. 2 is a view similar to fig. 1 of a part of a device according to a first preferred embodiment of the invention,

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- Fig. 3 is a view similar to fig. 2 of a device according to a second preferred embodiment of the invention,
- 5 Fig. 4 is a view similar to fig. 2, of a device according to a third preferred embodiment of the invention,
- Fig. 5 is a view similar to fig. 2 of a device according to a fourth preferred embodiment of the invention,
- 10 Fig. 6 is a view similar to fig. 2 of a device according to a fifth preferred embodiment of the invention,
- Fig. 7 is a view similar to fig. 2 of a device according to a sixth preferred embodiment of the invention,
- 15 Fig. 8 is a view similar to fig. 2 but somewhat simplified of a device according to a seventh preferred embodiment of the invention, and
- 20 Fig. 9 is a longitudinal cross section view substantially perpendicularly, i.e. from above, to the view according to fig. 8 of the device shown in fig. 8.

25 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Fig. 2 shows schematically a part of a device according to a preferred embodiment of the invention for epitaxially growing objects, in the following description by way of example referred to as SiC, by a method according to a preferred embodiment of the invention. It is obvious that the device in question also comprises many other means, such as pumps, but conventional equipment having nothing to do with the invention has been omitted for the sake of clearness and concentration to the conventional characteristics. The only difference between this device and the prior art device according to fig. 1 is that the sub-

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strate 3 is arranged in another way inside the susceptor in the device according to the invention than in fig. 1. More exactly, the device has means 7 for holding the substrate in the path 8 of said gas mixture through the susceptor at a distance away from internal walls 9 of the susceptor, in this case the bottom thereof. This holding means are here four graphite screws, one in each corner of a plate 10, preferably of SiC, on which the substrate 3 is arranged. Two elongated ribs of graphite extending in the flowing distribution may carry the plate instead of the screws. The SiC-plate 10 is therefor preventing etching of the rear side of the substrate.

The holding means are arranged to hold the substrate separated from said internal walls 9 by distance exceeding the thickness of a boundary layer 1 formed by the leading edge 4 of the susceptor. This means that the thickness 11 of the boundary layer over the substrate will now only depend on the distance between the leading edge 12 of the plate 10 and the substrate 3. As already said, this distance can be made as short as wanted, so that the diffusive length from the free flow of species through the susceptor may be reduced considerably and by that the growth rate increases correspondingly.

In the case of growing crystals of SiC it will be preferred to form said gas mixture of silane and propane as well as a carrier gas, such as Ar, H<sub>2</sub> or He. The heating means 6 will heat the susceptor to a temperature being high enough for cracking of the silane and propane when heated through the susceptor walls for forming Si and C depositing on the surface of the SiC crystal epitaxially grown. This means typically temperatures above 1 400°C, and preferably above 1 600°C.

The substrate 3 is arranged in the mid region 13 of the susceptor with respect to said path, and it is difficult to arrange it further upstream in the susceptor, since the precursors have to be heated enough before they reaches the substrate 3.

Another important advantage of separating the substrate 3 from the internal walls of the susceptor, so that it will have substantially no contact with said walls (except from the holding means 7) is that the back growth on the rear side of the SiC-plate 10 is reduced, since there is no longer such a large temperature difference between the front and rear side of the plate.

A device according to a second preferred embodiment of the invention is shown in fig. 3, and this has two holding means 7, one connected to a ceiling 14 of the susceptor for holding substrates 3 at said distance therefrom and another connected to the bottom 15 of the susceptor for holding other substrates at said distance therefrom. In this case two substrates are arranged in series along the gas mixture flow path, and this is made possible, since the temperature gradient in the flowing direction will be substantially decreased thanks to the fact that heat energy is substantially only transferred to the plates and the substrates through radiation. Accordingly, approximately the same temperature will prevail for the substrates arranged in series on a plate, so that objects may be grown thereon under substantially identical conditions. This embodiment means that layers of SiC may be grown at a much higher production rate than before, as a consequence of both a considerable reduction of said diffusive length and more substrates at the same time in the susceptor. More exactly, it has turned out that the growth rate depending on the shorter diffusive length may be increased considerably. At the same time, it may be possible to arrange for instance 2x2 substrates on the upper plate and just as many on the lower plate, so that then the production rate will increase further.

A device according to a third preferred embodiment is shown in fig. 4, and this differs from that shown in fig. 2 by the fact that the holding means is arranged to hold the substrate 3 inclined with respect to the path of the flow of said gas mixture through the susceptor, so that a perpendicular to the surface of the sub-

strate has a component in the direction opposite to the direction of said flow. The angle made by the surface of the substrate 3 with the direction of the flow is small, preferably 1-15°. This results in optimal conditions for the growth.

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A device according to a fourth preferred embodiment of the invention is schematically shown in fig. 5. It is here illustrated how the walls of the susceptor 5 of dense graphite are surrounded by a heat-insulating layer 16 of foam. Some heat shields 17 are arranged downstream of the outlet of the susceptor for said flow of gases for reflecting thermal energy back towards the susceptor, which is indicated by the arrows 18. The hottest point in a conventional susceptor is located just in the mid region of the susceptor. After this position the temperature is decreasing. The temperature decrease is caused by thermal conduction. In the device according to fig. 5 the outlet/end wall exchanges energy with the surrounding by radiation. Because radiated energy is proportional to temperature to the fourth power, the contribution from the surrounding is negligible. The heat shield will find a temperature much closer to the outlet/end wall, and the radiative energy from the shield towards the susceptor will not be negligible, so that the energy will be "trapped" inside the shield. This means that it is possible to grow objects also in the end region of the susceptor under substantially the same temperature conditions as in the mid region, so that a possible growth region is extended and more objects may be grown simultaneously increasing the production rate of the device.

A device according to a fifth preferred embodiment of the invention is illustrated in fig. 6, and this differs from those already shown by the fact that the susceptor 5 is at a downstream end thereof prolonged by an outlet 19 substantially beyond the end of the heating means 6. This means that the heat loss from the susceptor is decreased, which is due to that the outlet will insulate the susceptor from the cooling flow and the thermal radiation losses, but also due to that the outlet 19 will be heated by

the coil. Furthermore, the end effect and its eddy current flow is moved to the rear part of the outlet instead of the rear part of the susceptor. Finally, the outlet will work as a diffuser which will cause better flow conditions for the hot flow that leaves the  
5 susceptor. Accordingly, it will be possible to increase the number of objects grown in the susceptor without changing the susceptor geometry.

A device according to a sixth preferred embodiment of the invention is shown in fig. 7, and this differs from that shown in fig. 5 by the fact that the internal walls 5 are inclined, so that the same effect as in the embodiment according to fig. 4 is obtained, and that a funnel-like inlet 20 converging in the direction towards the susceptor and conducting said gas mixture into the  
15 susceptor is arranged. The inlet 20 has a first part 21 of quartz extending from the outer quartz tube 22 surrounding the susceptor and a second part 23 of graphite connecting to the susceptor. The funnel is circular with the same diameter as the quartz tube 22 at one end and rectangular with the same dimensions as the susceptor inlet hole at the other end. This funnel  
20 will improve the flow pattern of the gas mixture, insulate the susceptor from the cooling gas and will instead pre-heat the gas before it enters the susceptor more efficiently, insulate the susceptor from the radiative losses and shield off the gas flow from  
25 the rigid graphite insulation 16 and thereby decrease the amount of impurities coming from it. The inlet funnel is made of two different materials, because it is very hard (or impossible) to machine the whole in graphite.

A device according to a seventh preferred embodiment of the invention is shown in fig. 8 and 9, and this differs from those shown in the other figures mainly by the fact that the holding means 7 for the substrate 3 extends from a rear part 24 of the  
30 susceptor with respect to the flow direction of said gas mixture through the susceptor in the direction opposite to said flow while  
35 being separated from and without contact with the internal walls

9 of the susceptor along the extension thereof from said rear part. More exactly, the holding means comprises a member 25 having a fork-like design with two outer forks 26 secured to opposite lateral walls 27, 28 of the susceptor while being separated by them from a room 29 in which the growth is intended to take place. This is achieved by arranging longitudinal tracks in said walls into which the forks 26 are intended to be received. The member 25 has also a part 30 extending into said room 29 in the opposite direction to said flow in the form of two inner forks. These are arranged to carry a plate 10, preferably of SiC, extending into the room and on which the substrate 3, in this case two substrates, is arranged.

Thanks to the fact that the holding means can hold the plate 10 an by that the substrate 3 without touching any internal wall, i.e. floor, ceiling or lateral walls, of the susceptor room, problems of material transport from the walls to said holding means due to thermal gradients are efficiently avoided, so that the susceptor lifetime will be prolonged with respect to the embodiments illustrated in the other figures with holding means being attached to the internal walls. In such a case the temperature gradient between the susceptor walls and the holding means will cause material transport of the SiC-coating from the walls to the holding means (rods). Thereby the susceptor graphite will after a certain period of time be bared and the total pressure of hydrocarbons in the reactor will be increased. This is also a serious problem for the case when the loading plate is placed directly on the susceptor floor. This means that the susceptor lifetime is reduced, but more serious is as mentioned that the carbon plus impurities coming from the susceptor will be additionally uncontrolled growth parameters is not the susceptor taken out of operation in time. Another very important advantage of this way to hold the substrates is that the conditions for the growth of objects in different batches will be nearly exactly the same, so that the reproducibility of the objects will be excellent. This is due to arrangement of small marks not shown on the loading plate de-

termining the position for each substrate, preferably by a snap-in action, and to the fact that forks 26 may be very exactly positioned in the tracks, so that the substrates in different batches will always have the same position. The angle of the substrates with respect to the gas flow will also always be the same.

The invention is of course not in any way restricted to the preferred embodiments of the device and method described above, but several possibilities to modifications thereof would be apparent for a man with ordinary skill in the art without departing from the basic idea of the invention.

The definition "object" in the claims is made for including the epitaxial growth of all types of crystals, such as layers of different thicknesses as well as thick boules.

All definitions concerning the material of course also include inevitable impurities as well as intentional doping. The holding means may have another appearance or be made of another material than described above.

The relative dimensions of the distance between opposite susceptor walls, the distance between the substrate and the susceptor walls etc. may be totally different than shown in the figures.

## Claims

1. A method for epitaxially growing objects by Chemical Vapour Deposition on a substrate (3) arranged in a susceptor (5), in  
5        which a gas mixture with components for said growth is fed into the susceptor to the substrate and the substrate and the gas mixture fed thereto are heated through heating the susceptor, characterized in that the substrate is held in the path of said gas mixture through the susceptor at a distance  
10        (a) from internal walls (14, 15) thereof.
2. A method according to claim 1, characterized in that the substrate (3) is held separated from said internal walls of the susceptor by at least a distance (a) corresponding to the  
15        thickness of a boundary layer (1) with a lower velocity of the gas mixture and created by a leading edge of the susceptor at the upstream thereof with respect to the flow of the gas mixture through the susceptor.
- 20        3. A method according to claim 1 or 2, characterized in that at least two substrates (3) are held in series along said gas mixture flow path at said distance from internal walls of the susceptor.
- 25        4. A method according to any of claims 1-3, in which the susceptor is arranged so as to make said path to extend substantially horizontally therethrough, characterized in that at least one substrate (3) is held in the susceptor at said distance from the ceiling (14) thereof and at least one substrate is held in said susceptor at said distance from the  
30        bottom (15) thereof.
- 35        5. A device for epitaxial growth of objects by Chemical Vapour Deposition on a substrate (3) comprising a susceptor adapted to receive said substrate and means (6) for heating walls of the susceptor (5) surrounding the substrate and by

that the substrate and a gas mixture fed to the substrate for the growth, characterized in that it further comprises means (7, 10) for holding the substrate in the path (8) of said gas mixture through the susceptor at a distance from internal walls (14, 15) thereof.

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6. A device according to claim 5, characterized in that said means (7, 10) is arranged to hold the substrate separated from said internal walls (14, 15) of the susceptor by at least a distance (a) corresponding to the thickness of a boundary layer (1) with a lower velocity of the gas mixture and created by a leading edge (4) of the susceptor at the upstream end thereof with respect to the flow of the gas mixture through the susceptor.
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7. A device according to claim 5 or 6, characterized in that said means (7) extends from a rear part (24) of the susceptor with respect to the flow direction of said gas mixture through the susceptor in the direction opposite to said flow while being separated from and without contact with said internal walls of the susceptor along the extension thereof from said rear part.
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8. A device according to claim 7, characterized in that said holding means (7) is arranged to hold the substrate (3) at a distance from said rear part (24) as seen in the direction of said flow.
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9. A device according to claim 7 or 8, characterized in that said holding means (7) is secured outside a room (29) of the susceptor defined by said internal walls (9) and in which said growth is intended to take place and extends into said room without any contact to said walls therein.
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10. A device according to claim 9, characterized in that said holding means comprises a member (25) secured to the

susceptor outside said room (29) and said member has a fork-like design with at least two forks (26) secured to opposite walls of the susceptor while being separated by them from said room (29).

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11. A device according to claim 10, characterized in that said member (25) has a part (30) extending into said room in the opposite direction to said flow.

10 12. A device according to any of claims 9-11, characterized in that said holding means comprises a member (25) secured to the susceptor outside said room (29) and arranged to hold a plate (10) extending into said room and on which the substrate (3) is arranged.

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13. A device according to claims 11 and 12, characterized in that said part (30) of said member (25) is arranged to carry said plate (10).

20 14. A device according to any of claims 5-13, characterized in that said holding means comprises a plate (10) of SiC, on which the substrate is arranged.

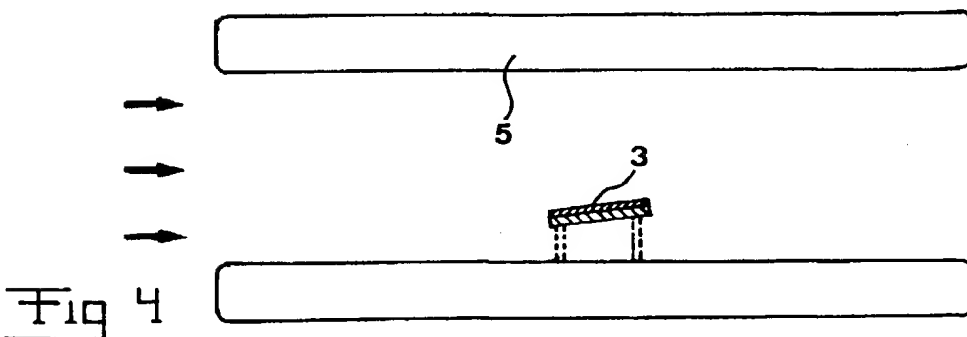
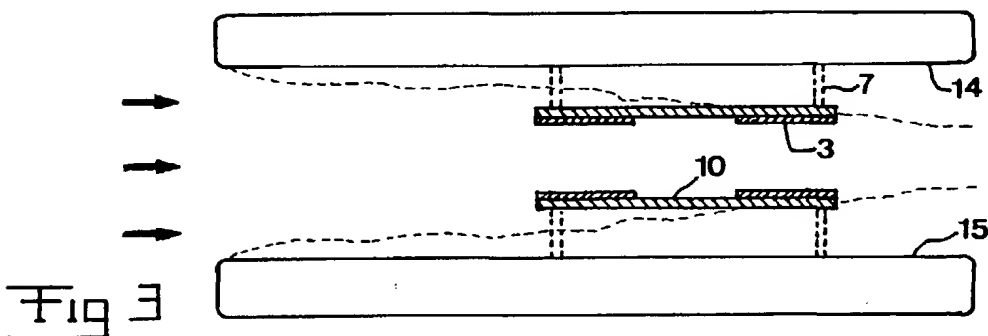
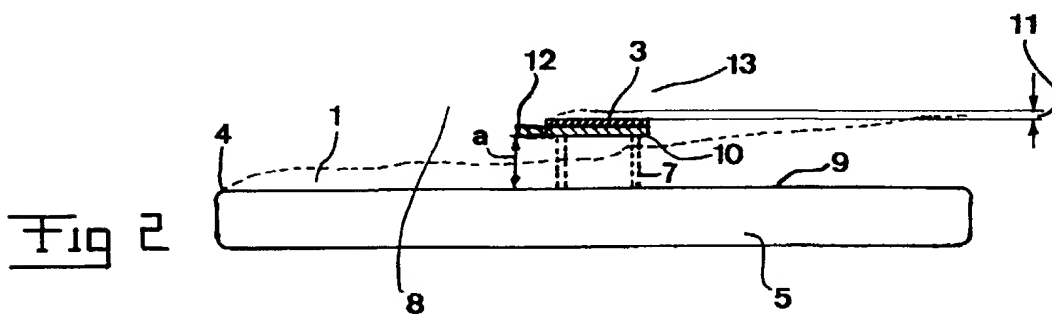
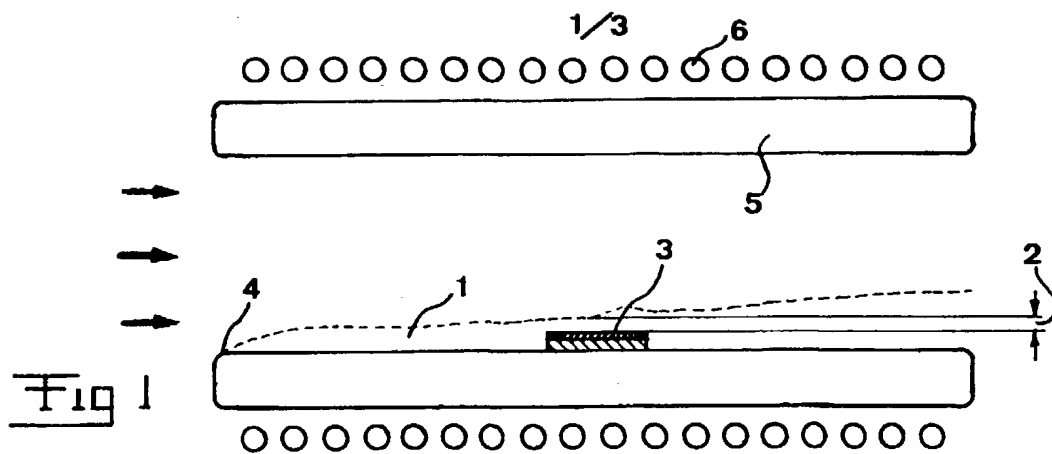
25 15. A device according to any of claims 5-14, characterized in that said holding means comprises a plate (10), on which at least two substrates (3) are arranged in series along said gas mixture flow path (8) at said distance (a) to internal walls (14, 15) of the susceptor.

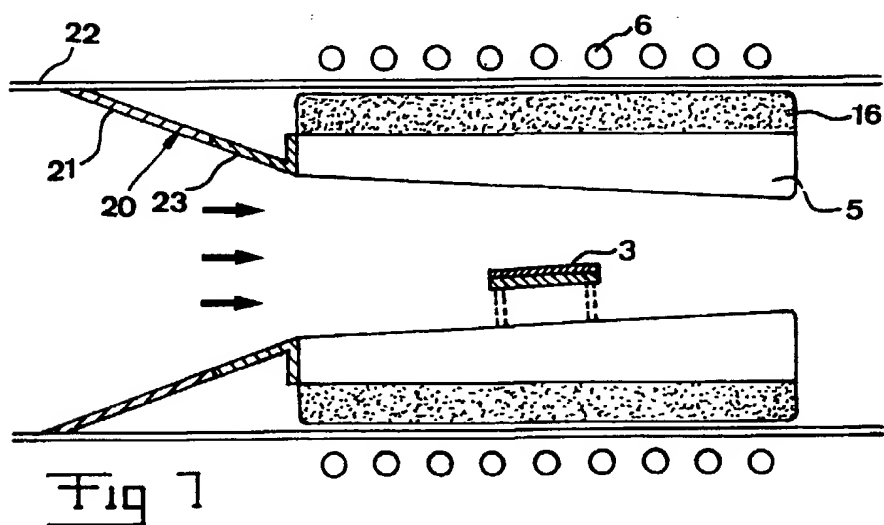
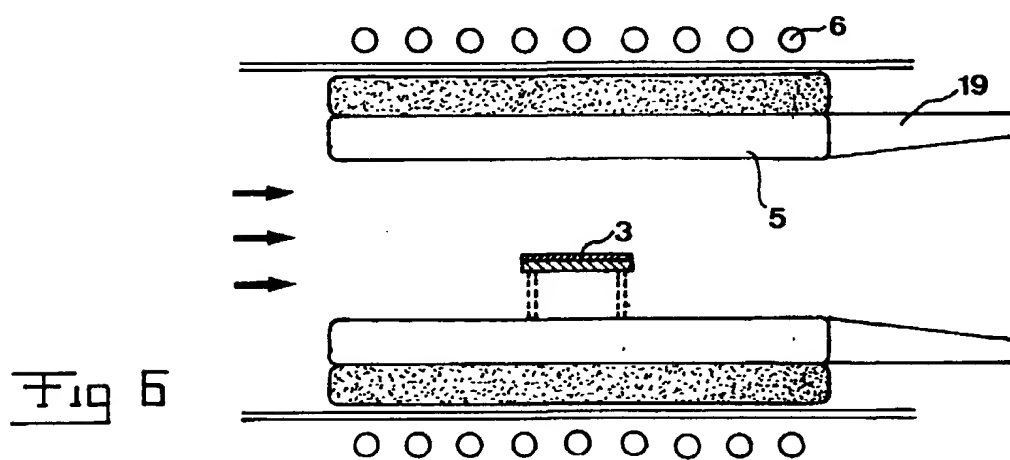
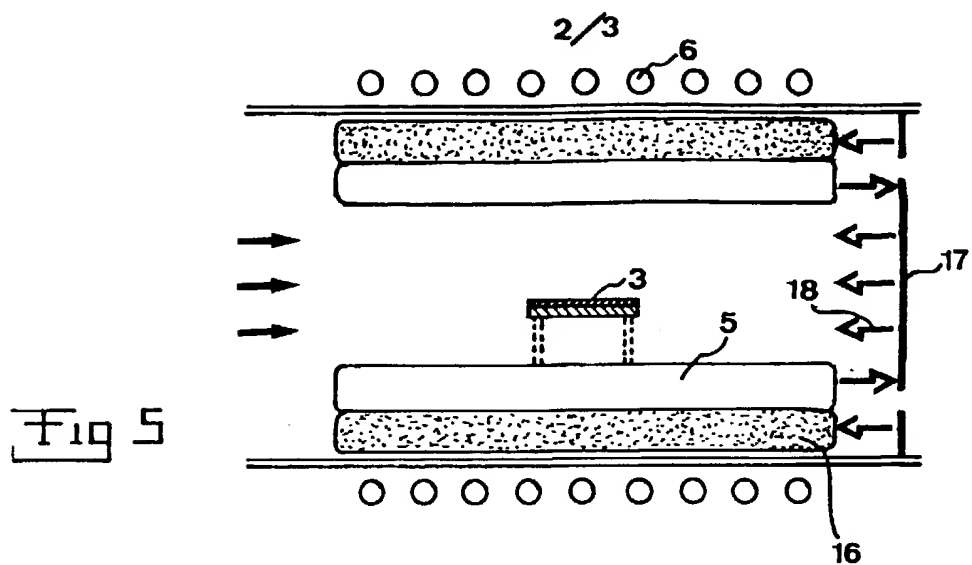
30 16. A device according to any of claims 5,6 and 14,15, in which the susceptor is adapted to be arranged with said path (8) extending substantially horizontally therethrough, characterized in that it comprises two holding means (7, 10), one connected to a ceiling (14) of the susceptor for holding a  
35 substrate (3) at said distance therefrom and another con-

nected to the bottom (15) of the susceptor for holding another substrate (3) at said distance therefrom.

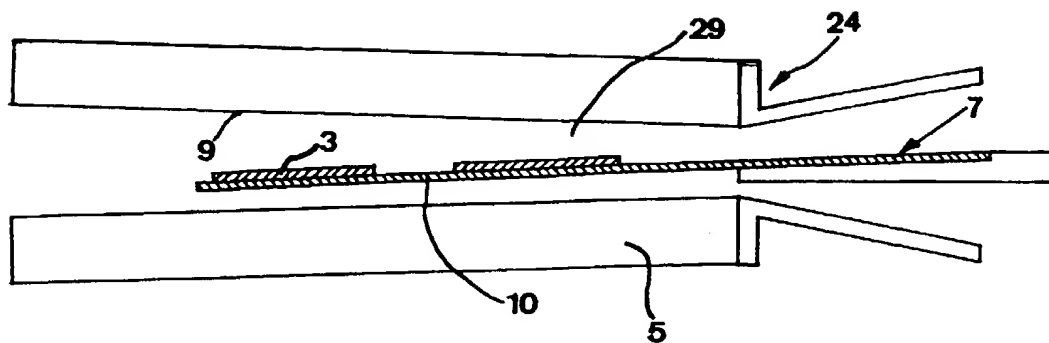
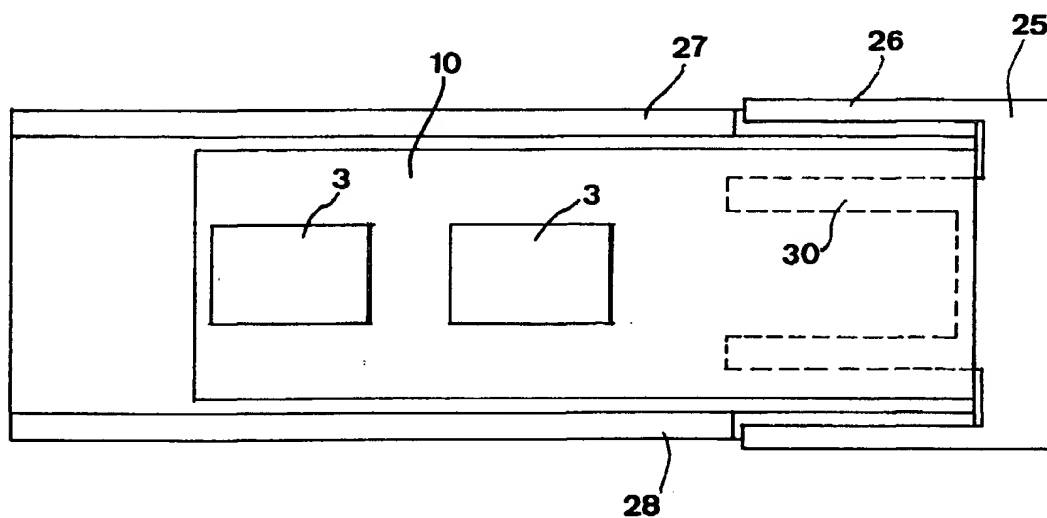
- 5 17. A device according to any of claims 5-16, characterized in that said means (7, 10) is arranged to hold the substrate (3) in the mid region (13) of the susceptor with respect to said path between an inlet and an outlet thereof for said gas mixture.
- 10 18. A device according to any of claims 5-17, characterized in that said means (7, 10) is arranged to hold the substrate (3) inclined with respect to the path of the flow of said gas mixture through the susceptor, so that a perpendicular to the surface of the substrate has a component in the direction  
15 opposite to the direction of said flow.
19. A device according to any of claims 5-18, characterized in that the susceptor is at a downstream end thereof prolonged by an outlet (19) substantially beyond the end of the heating  
20 means (6).
20. A device according to any of claims 5-19, characterized in that at least one heat shield (17) is arranged downstream of an outlet of the susceptor for said flow of gases for reflecting thermal energy back towards the susceptor.  
25
21. A device according to any of claims 5-20, characterized in that it has an inlet (20) connected to the upstream end of the susceptor and formed by converging walls guiding said  
30 gas mixture into the susceptor.
22. A device according to any of claims 5-21, characterized in that the walls of the susceptor (5) are made of dense graphite.  
35

23. A device according to any of claims 5-22, characterized in that the heating means (6) is arranged to radiate a Rf-field.
- 5 24. A device according to any of claims 5-23, characterized in that it is adapted for the growth of an object of SiC, a group III-nitride or alloys of either SiC and one or more group III-nitrides or two or more group III-nitrides.
- 10 25. A device according to any of claims 5-24, characterized in that said heating means (6) is arranged to heat the susceptor and by that said substrate (3) and gas mixture to a temperature above 1 400°C.





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Fig 8Fig 9

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 99/00532

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
IPC6: C30B 25/08, C30B 25/12, C30B 25/14, C30B 29/36, C30B 35/00 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
IPC6: C30B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0147967 A2 (APPLIED MATERIALS, INC.), 10 July 1985 (10.07.85), page 5, line 9 - page 6, line 2, figure 4	1-4,5-6, 14-18
Y	--	7-13,19-25
X	Patent Abstracts of Japan, Vol 11, No 43, C-402 abstract of JP 61-205695 A (SUMITOMO ELECTRIC IND LTD), 11 Sept 1986 (11.09.86), the figure, abstract	1-4,5-6, 14-19
Y	--	7-13,20-25
Y	EP 0068839 A1 (FUJITSU LIMITED), 5 January 1983 (05.01.83), figures 2,4, abstract	7-13
	--	
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
14 June 1999		09.07.1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer  Ulrika Nilsson/ELY Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 99/00532

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	J. Electrochem.Soc., Volume 143, No 9, Sept 1996, N. Nordell et al, "Design and Performance of a New Reactor for Vapor Phase Epitaxy of 3C, 6H and 4H SiC", page 2910 - page 2919, figure 1  --	19-20,22-25
Y	JP 1320292 A(MITSUBISHI DENKI KK) 1989-12-26 (abstract) World Patents Index (online). London, U.K.: Derwent Publications, Ltd. (retrieved on 1999-06-14) Retrieved from: EPO WPI Database. DW9006, Accession No. 90-042080; & JP 1320292 (MITSUBISHI ELECTRIC CORP)1990-03-08 (abstract).(online)(retrieved on 1999-06-14). Retrieved from: EPO PAJ Database;  -- -----	21

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

01/06/99

International application No.

PCT/SE 99/00532

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0147967 A2	10/07/85	DE 3485898 A JP 60186013 A US 4579080 A	01/10/92 21/09/85 01/04/86
EP 0068839 A1	05/01/83	JP 58002294 A US 4507169 A	07/01/83 26/03/85